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Cost-Effectiveness of Switching to Biphasic Insulin Aspart 30 from Human Insulin in Patients with Poorly Controlled Type 2 Diabetes in South Korea

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ABSTRACT

Objectives: To estimate the cost-effectiveness of switching patients with poorly controlled type 2 diabetes mellitus from human insulin (HI) to biphasic insulin aspart 30 (BIAsp 30) in South Korea.

Methods: A published and validated diabetes computer simulation model (the IMS CORE Diabetes Model) was used to evaluate the long-term clinical and economic outcomes associated with switching to BIAsp 30, using treatment effects from the South Korean subgroup of the Physician's Routine Evaluation of Safety and Efficacy of NovoMix® 30 Therapy study and cost data collected through primary research. Outcomes included life expectancy, quality-adjusted life expectancy, incidence of complications, direct medical costs, and cost-effectiveness. Analyses were performed from a third-party payer perspective over a 30-year time horizon. Future costs and clinical benefits were discounted at 5% per annum. Extensive sensitivity analyses were performed.

Results: Switching patients uncontrolled on HI to BIAsp 30 was projected to increase discounted mean life expectancy by 0.15 ± 0.18 years per patient (8.62 ± 0.13 years vs. 8.47 ± 0.13 years) and improve discounted mean quality-adjusted life expectancy by 0.30 ± 0.12 quality-adjusted life-years (QALYs) per patient (5.68 ± 0.09 QALYs vs. 5.38 ± 0.09 QALYs). Conversion to BIAsp 30 was associated with a mean increase in direct costs of South Korean Won (KRW) 1,777,323 ± 359,209 over patient lifetimes. BIAsp 30 was associated with an incremental cost-effectiveness ratio of KRW5,916,758 per QALY gained versus HI.

Conclusion: Switching patients uncontrolled on HI to BIAsp 30 was projected to improve life expectancy and quality-adjusted life expectancy. This analysis suggests that BIAsp 30 could be a cost-effective treatment option in type 2 diabetes patients poorly controlled on HI in South Korea.

Keywords: biphasic insulin aspart 30, cost-effectiveness, modeling, South Korea, type 2 diabetes.

Introduction

Type 2 diabetes is a leading cause of morbidity and mortality worldwide. The World Health Organization estimates that diabetes is responsible for approximately 5% of all deaths worldwide, with global diabetes-related mortality predicted to increase by more than 50% over the next 10 years [1]. The prevention, management, and treatment of type 2 diabetes and diabetes-related complications place a substantial burden on health-care systems and present a considerable public health challenge to national health-care systems, particularly in middle-income countries experiencing proportionally higher growth in noncommunicable diseases compared with the Organisation for Economic Co-operation and Development countries [2]. The costs associated with treating type 2 diabetes and, in particular, associated complications make up a substantial proportion of overall health-care spending. For example, the American Diabetes Association estimated that in the United States in 2007, approximately US$1 in every US$5 spent on health care was spent on caring for someone with diabetes and that US$1 in every US$10 spent on health care was directly attributable to the disease [3].

In South Korea, mortality due to diabetes has increased more than threefold since the 1980s, from 5.3 per 100,000 in 1983 to 18.4 per 100,000 in 2001 [4], making it the fourth leading cause of mortality [5]. Within the same time frame (1983–2001), South Korea experienced a fivefold decrease in the mortality rate from infectious diseases, increased urbanization, a fivefold increase in economic output, and substantial lifestyle and dietary changes including an increase in animal protein and fat intake. Such changes are thought to be a major contributing factor in the increasing prevalence of diabetes in South Korea. This is particularly evident in the elderly, with prevalence rates in the population aged >60 years reported to be 18% in males and 21% in females [6]. Moreover, a study by Yoon et al. [7] reported that diabetes is associated with the highest burden of disease in terms of total disability-adjusted life-years in both men and women, surpassing other illness groups including cardiovascular disease (CVD) and cancer. Recent studies also indicate that a significant proportion of patients with type 2 diabetes in Korea are managed suboptimally in terms of diabetes-associated risk factors. Yun et al. [8] investigated the management of cardiovascular risk factors in patients with type 2 diabetes in an urban area of South Korea; the management and follow-up of blood pressure, low-density lipoprotein (LDL) cholesterol, and microalbuminuria testing was variable. This finding was pertinent given that CVD is the leading cause of death in patients with type 2 diabetes.

The Physician's Routine Evaluation of Safety and Efficacy of NovoMix® 30 Therapy (PRESENT) study was a 6-month, single-arm, open-label, observational study conducted in 15 different countries, including South Korea [9]. Patients with type 2 diabetes inadequately controlled on their current therapy, which included oral antidiabetic drugs (OADs), insulin, OAD plus insulin, or dietary modification, were switched to biphasic insulin aspart 30 (BIAsp 30) either as monotherapy or in combination with OADs. BIAsp 30 is an insulin analog that consists of a

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short-acting soluble component (30%) and a long-acting protamine-crystallized insulin aspart (70%). Randomized, controlled clinical trials have shown that BIAsp 30 improves glycemic control versus baseline and lowers the long-term rate of hypoglycemic events compared with biphasic human insulin (HI) 30 [10,11]. The PRESENT study was an evaluation of BIAsp 30 within routine clinical practice. Results from a subgroup analysis of the South Korean PRESENT study population receiving HI at baseline show that 6 months after switching to BIAsp 30 treatment, glycosylated hemoglobin (HbA1c) was reduced by 0.82% points ($P < 0.001$) from baseline. All hypoglycemic events (major and minor) were reduced from 494 to 188 events per 100 patient years ($P < 0.001$). These benefits were accompanied by a slight increase in body mass index (BMI) of 0.18 kg/m^2 ($P < 0.001$) (Novo Nordisk data on file [12]).

The aim of this cost-effectiveness analysis was to estimate the long-term clinical and cost outcomes associated with switching patients poorly controlled on HI to BIAsp 30 in South Korea based on the data from the PRESENT study.

Methods

Model

The IMS CORE Diabetes Model, a published and validated computer simulation model, was used to estimate the long-term cost-effectiveness of switching to BIAsp 30 from HI (for a detailed description of the methodology of the model, see Palmer et al. [13]). In summary, the model is a nonproduct-specific policy analysis tool that takes into account intensive or conventional insulin therapy, oral hypoglycemic medications, screening and treatment strategies for microvascular complications, treatment strategies for end-stage complications, and multifactorial interventions. Disease progression through the model is based on a series of 15 interdependent submodels that simulate progression of disease-related complications. The 15 interdependent submodels estimate complication probabilities for: angina, myocardial infarction, congestive heart failure, stroke, peripheral vascular disease, diabetic retinopathy, macula edema, cataract, hypoglycemia, ketoacidosis, lactic acidosis, nephropathy, neuropathy, foot ulcer and amputation, and nonspecific mortality. Each submodel uses time, state, and diabetes type-dependent probabilities derived from published sources. Validation of the model has been performed, both against the data sources used and external longitudinal studies [14].

Treatment Effects

Treatment effects applied in the simulation included the change from baseline in HbA1c, hypoglycemic event rates (major and minor), and BMI observed in the South Korean subgroup analysis of PRESENT (n = 1321). Consequently, patients receiving concomitant OADs and those receiving HI were included for the analysis. Reductions in HbA1c were modeled as an initial decline followed by a natural progression over time as observed in the United Kingdom Prospective Diabetes Study (UKPDS) [15]. Recorded changes in BMI and hypoglycemic event rates (in terms of events per 100 patient years) were also applied for the simulations.

Simulated Cohort

A hypothetical cohort of 1000 patients was generated within the model. The baseline demographics, characteristics, risk factors, and comorbidities were derived from the South Korean PRESENT subgroup and from published studies in comparable populations where necessary [4,16–22]. A complete list of baseline patient demographics, characteristics, and comorbidities are shown in Table 1.

Table 1 Baseline patient demographics and complications

	Mean (SD)	Source
Patient demographics		
Baseline age (years)	57.93 (13.64)	PRESENT
Duration of diabetes (years)	11.02 (7.17)	PRESENT
Percentage male (%)	45.7	PRESENT
Baseline risk factors		
HbA1c (%)	8.82 (1.61)	PRESENT
Systolic blood pressure (mm Hg)	139.1 (21.9)	[16]
Total cholesterol (mg/dl)	201.6 (41.3)	[16]
HDL (mg/dl)	52 (13.1)	[16]
LDL (mg/dl)	119.5 (34.2)	[16]
Triglyceride (mg/dl)	158.6 (116.6)	[16]
Body mass index (kg/m^2)	24.57 (3.21)	PRESENT
Racial characteristics		
Proportion white	0	Assumed
Proportion black	0	Assumed
Proportion Hispanic	0	Assumed
Proportion Native American	0	Assumed
Proportion Asian/Pacific Islander	1	Assumed
Baseline cardiovascular complications		
Proportion with myocardial infarction	0.04	[17]
Proportion with angina	0.017	[22]
Proportion with peripheral vascular disease	0.011	[19]
Proportion with stroke	0.048	PRESENT
Proportion with congestive heart failure	0.13	PRESENT
Proportion with atrial fibrillation	0.005	[20]
Proportion with left ventricular hypertrophy	0.017	[20]
Baseline renal complications		
Proportion with microalbuminuria	0.397	[21]
Proportion with gross proteinuria	0.19	PRESENT
Proportion with end-stage renal disease	0	Assumed
Baseline eye complications		
Proportion with background diabetic retinopathy	0.397	[31]
Proportion with proliferative diabetic retinopathy	0.088	[31]
Proportion with severe vision loss	0	Assumed
Proportion with macular edema	0.081	[31]
Proportion with cataract	0.043	[22]
Baseline foot ulcer complications		
Proportion with uninfected ulcer	0.036	PRESENT
Proportion with infected ulcer	0	Assumed
Proportion with healed ulcer	0	Assumed
Proportion with history of amputation	0	Assumed
Baseline neuropathy		
Proportion with neuropathy	0.376	PRESENT

HbA1c, glycosylated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein; PRESENT, Physician's Routine Evaluation of Safety and Efficacy of NovoMix® 30 Therapy; SD, standard deviation.

Costs and Perspective

A third-party payer perspective was adopted for the analysis, incorporating the direct costs of treatment, patient management, and diabetes-related complication costs. Primary cost collection research was performed by the authors where published data were unavailable. Diabetes-related complication costs were obtained using a cost questionnaire that was sent to 54 South Korean clinicians (Table 2). The participating clinicians included clinic and hospital-based endocrinologists (n = 10) and other specialists managing patients with complications including cardiologists (n = 7), nephrologists (n = 7), neurologists (n = 5), surgeons (n = 6), ophthalmologists (n = 6), and internists (n = 13) from metropolitan areas of South Korea.

All costs were accounted in 2007 South Korean Won (KRW; US$1 = KRW936.53). Prices of HI and BIAsp 30 were obtained from IMS data. The costs of self-monitoring blood glucose strips

Table 2 Diabetes-related complication and management costs based on clinician survey in Korea in 2007

	KRW
Management costs	
Annual cost of statins	129,456
Annual cost of aspirin	18,300
Annual cost of microalbuminuria screening	32,050
Annual cost of macroalbuminuria screening	24,460
Annual cost of eye screening	56,310
Annual cost of foot screening	171,480
Direct costs of CVD complications	
Cost of myocardial infarction, year of event	3,080,290
Cost of myocardial infarction, subsequent years	1,092,070
Cost of angina, year of onset	1,750,000
Cost of angina, subsequent years	626,540
Cost of coronary heart failure, year of onset	1,295,830
Cost of coronary heart failure, subsequent years	797,500
Cost of stroke, year of event	2,808,700
Cost of stroke, subsequent years	880,000
Cost of stroke, death within 30 days of event	6,111,110
Direct costs of renal complications	
Cost of hemodialysis, first year	5,277,780
Cost of hemodialysis, subsequent years	4,444,440
Cost of peritoneal dialysis, first year	5,277,780
Cost of peritoneal dialysis, subsequent years	4,444,440
Cost of renal transplant, year of procedure	18,571,430
Cost of renal transplant, subsequent years	3,214,290
Direct costs of acute events	
Cost of major hypoglycemic event	440,000
Cost of ketoacidosis event	1,703,130
Cost of lactic acidosis event	1,113,330
Direct costs of eye disease	
Cost of laser treatment procedure	400,000
Cost of cataract operation, year of procedure	1,200,000
Direct costs of other complications	
Cost of amputation event	2,961,540
Cost of prosthesis after amputation event	2,533,330

ACE, angiotensin-converting enzyme; CVD, cardiovascular disease; KRW, South Korean Won.

and OAD treatments were excluded from the analysis, because they were assumed not to differ between treatment arms.

Discounting and Time Horizon

In the base-case analysis, future costs and clinical benefits were discounted at a rate of 5% per annum, in accordance with Korean Health Insurance Review Agency guidelines (http://www.ispor.org/PEguidelines/index.asp). The analysis was performed over a time horizon of 30 years to capture the incidence of all diabetes-related complications and associated costs over patient lifetimes.

Sensitivity Analyses

A series of sensitivity analyses were performed to address the impact of several key parameters on final outcomes. The simulations performed in the sensitivity analysis were: 1) treatment efficacy—simulations were performed assuming an HbA1c improvement of half that was observed in the PRESENT trial, no HbA1c reduction, and no reduction in hypoglycemic events; 2) cost of complications—the costs associated with complications were increased by 20% and decreased by 20% to address uncertainty around cost collection data; 3) time horizon—simulations were performed using time horizons of 5, 10, and 20 years to assess outcomes over periods shorter than patient lifetimes; and 4) discount rates—a discount rate of 0% was applied.

Probabilistic sensitivity analysis (PSA) was also performed to address uncertainty at the patient and treatment effect level. PSA was done by sampling from the distributions generated around cohort characteristics (age, duration of diabetes, HbA1c, systolic blood pressure, total cholesterol, high-density lipoprotein, LDL, triglycerides, and BMI) and treatment effects (changes in HbA1c and BMI). Measures of dispersion were only incorporated where data were available.

Statistical Methodology

A simulated cohort of 1000 patients was run through the model 1000 times for each simulation (base-case and sensitivity analysis) using a nonparametric bootstrapping approach, and mean values and standard deviations were generated [23]. One thousand mean values (each of 1000 patients) of incremental costs and incremental effectiveness in terms of quality-adjusted life expectancy (QALE) were plotted (scatter plots) on a cost-effectiveness plane. Acceptability curves were generated based on the percentage of points on the scatter plots below a range of willingness-to-pay thresholds.

Results

Clinical Outcomes

In the base-case analysis, switching uncontrolled patients to BIAsp 30 was associated with a mean increase in life expectancy of 0.15 ± 0.18 years compared with continued HI treatment (Table 3) and a mean increase in QALE of 0.30 ± 0.12 quality-adjusted life-years (QALYs) per patient. Patients treated with BIAsp 30 were projected to have a lower overall incidence of diabetes-related complications and a slower onset of complications. In the BIAsp 30 group, patients remained free of complications for 0.73 years on average, compared with 0.63 years for

Table 3 Clinical and economic outcomes

	BIAsp 30	HI	Δ
Life expectancy (years)	8.62 (0.13)	8.47 (0.13)	0.15 (0.18)
Quality-adjusted life expectancy (QALYs)	5.68 (0.09)	5.38 (0.09)	0.30 (0.12)
Total costs	12,214,835 (259,424)	10,437,982 (253,378)	1,776,855 (358,623)
Treatment costs	5,315,031	2,371,708	2,943,323
Management costs	2,012,114	1,980,240	31,874
Cost of complications (KRW)			
Cardiovascular complications	3,386,327	3,493,907	−107,580
Nephropathy	922,096	1,168,179	−246,083
Ulcer, amputation, and neuropathy	338,353	335,160	3,193
Retinopathy	111,446	119,245	−7,799
Hypoglycemia	114,634	954,239	−839,605
Incremental cost-effectiveness ratio (KRW per QALY gained)		5,915,198	

Values shown are means with standard deviations in parentheses.
BIAsp 30, biphasic insulin aspart 30; HI, human insulin; KRW, South Korean Won; QALY, quality-adjusted life-year.

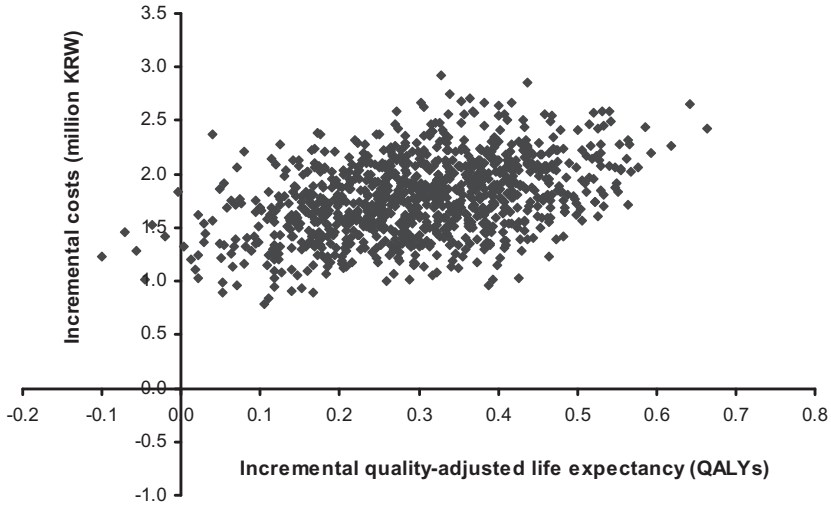

Figure 1 Incremental cost and quality-adjusted life expectancy for biphasic insulin aspart 30 versus human insulin.

HI. Among the most notable delays in onset were those for neuropathy and gross proteinuria, which were both delayed by 0.44 years by switching to BIAsp 30 (for neuropathy, 5.43 years to onset with BIAsp 30 vs. 4.99 years with HI; for gross proteinuria, 9.79 years for BIAsp 30 vs. 9.35 years for HI). In terms of the incidence of diabetes-related complications, BIAsp 30 reduced the overall incidence of neuropathy and renal, cardiovascular, ophthalmologic, and diabetic foot complications. The most pronounced reductions were observed in the incidence of neuropathy (3.54%) and gross proteinuria (2.86%). Treatment with BIAsp 30 led to a twofold reduction in the incidence of major hypoglycemic events and an eightfold reduction in the incidence of minor hypoglycemic events.

Cost Outcomes

Mean total direct costs associated with switching to BIAsp 30 were KRW1,777,323 per patient higher than treatment with HI (Table 3). The higher costs associated with BIAsp 30 treatment were mainly due to the 55% increase in drug acquisition costs. This is partly due to the fact that BIAsp 30-treated patients have a higher life expectancy than those treated with HI. As a result, BIAsp 30-treated patients will undergo treatment for a longer period of time and will likely have higher management costs associated with, for example, blood glucose monitoring and screening programs.

Treatment with BIAsp 30 was associated with a decrease in costs of most complications. Reductions in the costs of CVD, renal, and ophthalmologic complications were KRW107,580, KRW246,083, and KRW7799, respectively. In addition, the notable reduction in hypoglycemic events that was observed with BIAsp 30 led to a cost reduction of KRW839,605 compared with HI.

Cost-Effectiveness

In terms of life expectancy, the incremental cost-effectiveness ratio (ICER) calculated for BIAsp 30 was KRW11,899,882 per life-year gained (discounted), and the ICER based on QALE was KRW5,916,758 per QALY gained (discounted) (Table 3). Figure 1 shows the cost-effectiveness plane for the 1000 mean values, each consisting of 1000 patients. The data points on the scatter plot are located almost exclusively within the upper right-hand quadrant, indicating that BIAsp 30 is associated with higher cost and higher efficacy compared with HI.

Figure 2 shows a cost-effectiveness acceptability curve for BIAsp 30 versus HI, based on quality adjusted life-year outcomes. Assuming a willingness-to-pay threshold of KRW25 million per QALY gained (less than gross domestic product per capita on a purchasing power parity basis) [24], there is a 97.5% chance that BIAsp 30 will be cost-effective compared with HI. This value represents the percentage of points on the cost-effectiveness plane that fall under the willingness-to-pay threshold, based on 1000 bootstrap simulations.

Sensitivity Analysis

One-way sensitivity analysis was performed to assess the impact of changes in efficacy, complication costs, time horizon, and discount rates. To see Table S1, see Cost-Effectiveness of Switching to Biphasic Insulin Aspart 30 from Human Insulin in Patients with Poorly Controlled Type 2 Diabetes in South Korea *Value in Health* Supporting Information at: http://www.ispor.org/Publications/value/ViHsupplementary/ViH12s3_White.asp. The outcomes of the simulation were most sensitive to alterations in projected efficacy. Assuming that BIAsp 30 treatment resulted in no improvement in hypoglycemic events, the ICER (cost per

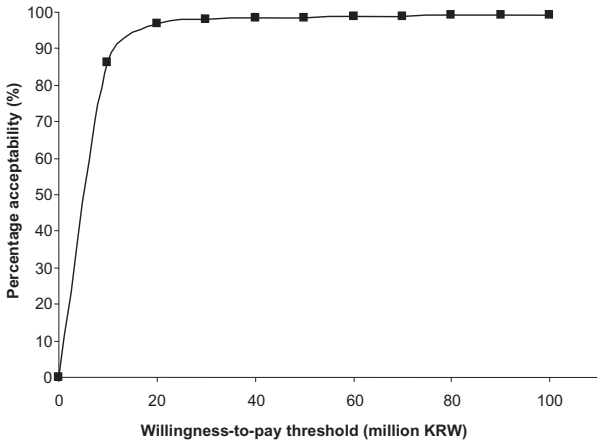

Figure 2 Cost-effectiveness acceptability curve for biphasic insulin aspart 30 versus human insulin.

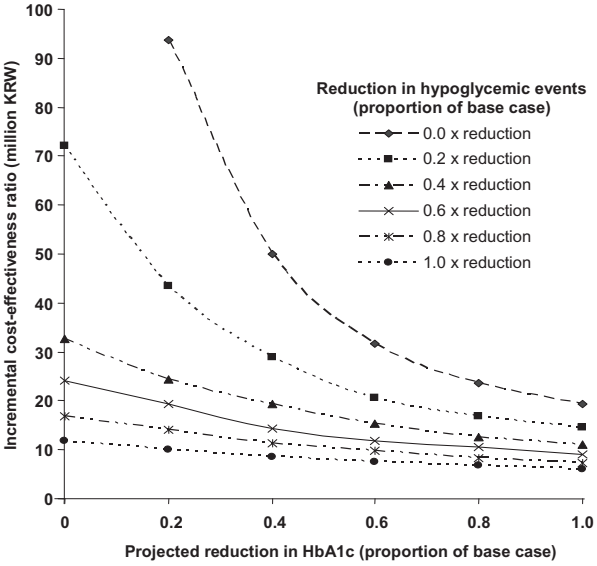

Figure 3 Two-way sensitivity analysis on biphasic insulin aspart 30-associated HbA1c and hypoglycemia reduction on the incremental cost-effectiveness ratio. HbA1c, glycosylated hemoglobin.

QALY gained) increased to KRW19,248,486, and the difference in QALE decreased to 0.137 QALYs. Likewise, if the improvement in terms of the projected reduction in HbA1c was halved or no reduction at all was projected, the ICER for BIAsp 30 was KRW8,037,980 per QALY gained and KRW11,911,421 per QALY gained, respectively; this was also accompanied by a reduction in the improvement in QALE to 0.231 and 0.137 QALYs. Increasing and decreasing complication costs by 20% had a minimal effect on the ICER. If complication costs were increased by 20%, the ICER was KRW5,119,207 per QALY gained. Decreasing complication costs by 20% resulted in an ICER of KRW6,714,304 per QALY gained. The ICER was also sensitive to time horizon and increased from KRW5,916,758 per QALY gained to 8,587,115 per QALY gained as the time horizon of the simulation was reduced from 30 years to 5 years. Nevertheless, performing the simulation over a time horizon of 5 years fails to capture any long-term benefits associated with switching to BIAsp 30, such as the avoidance of end-stage complications. Altering the discount rate to 0% had a minimal impact on the ICER.

One-way and two-way sensitivity analyses were performed by varying the projected reduction in both hypoglycemic events and HbA1c associated with switching to BIAsp 30 (Figure 3). Sensitivity analyses were performed using projected improvements of 0.2, 0.4, 0.6, and 0.8 times the magnitude of the improvements observed in the base-case. As projected, clinical improvements associated with switching to BIAsp 30 decreased and the ICER increased, however, the increases observed in the ICER were not linear. In terms of the magnitude of the impact that the projected improvements had on the ICER, as expected, small reductions in the observed improvements had a minimal impact on the ICER. By contrast, in situations where the efficacy of BIAsp 30 was significantly reduced, small changes in efficacy resulted in large changes in the ICER. For example, if the reduction in hypoglycemic events was assumed to be the same as in the base-case, an accompanying reduction in HbA1c from the base-case improvement value (–0.82% points) to 0.8 times (–0.66% points) was associated with an increase in the ICER from KRW5,916,758 per QALY gained to KRW6,692,074 per QALY gained. A decrease in HbA1c from 0.4 times (–0.33% points) to 0.2 times (–0.16% points) the reduction of the base case (–0.82% points), while assuming the full reduction in hypoglycemia, resulted in an increase in the ICER from KRW8,556,935 per QALY gained to KRW9,995,336 per QALY gained.

Incorporating second-order uncertainty into the simulation led to an increase in the ICER to approximately KRW10,147,797 per QALY gained and a reduction in the improvement in QALE to just 0.17 QALYs. PSA was also performed to address uncertainty, and the cost-effectiveness plane from the PSA is shown in Figure 4. The dispersion of points was greater when PSA was performed, however, the shape was more elliptical compared with the base-case because of the relatively few input parameters that incorporated uncertainty (due to data limitations) and the high influence of HbA1c in the model, which was varied probabilistically.

Discussion

Data from the PRESENT study have been reported elsewhere [9,25,26] and have shown that BIAsp 30 is an efficacious treat-

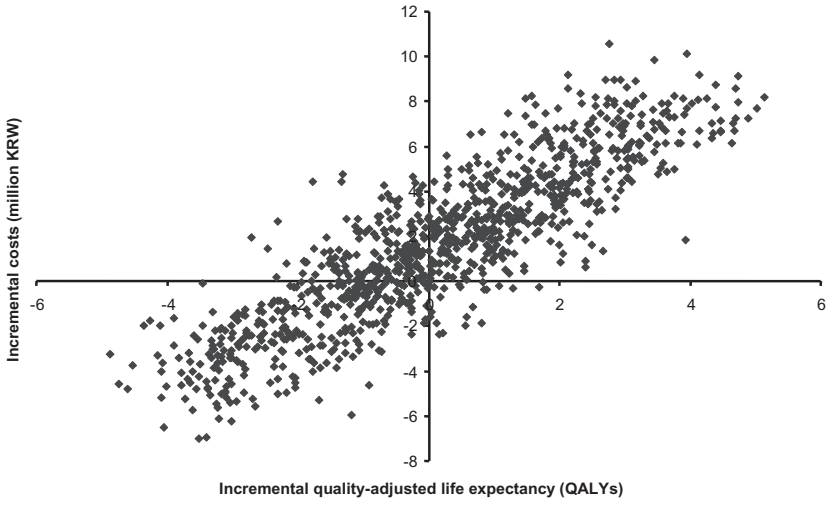

Figure 4 Cost-effectiveness plane for biphasic insulin aspart 30 versus human insulin when probabilistic sensitivity analysis was performed.

ment in patients with poorly controlled type 2 diabetes in a multinational setting. Subgroup analyses from the South Korean cohort reaffirms this. At 6 months, South Korean patients had a mean HbA1c reduction of 0.82% points and exhibited a greater than twofold reduction in hypoglycemic events after therapy conversion to BIAsp 30. Results from this analysis show that switching to BIAsp 30 treatment improves projected life expectancy by 0.15 ± 0.18 years and QALE by 0.30 ± 0.12 QALYs. Moreover, BIAsp 30 reduced the incidence of, and delayed the onset of, type 2 diabetes-related complications. The PRESENT study was designed as a single-arm, open-label, observational study, and patients that participated in the trial who had failed to achieve satisfactory glycemic control on previous medications were permitted to continue taking concomitant medications. As such, the clinical results may have been open to the influence of a number of confounding factors. The strengths and weaknesses of observational study data have been reported extensively elsewhere [27]. From the perspective of health outcomes research, observational trials arguably capture real-world clinical end points.

The total direct cost associated with switching patients to BIAsp 30 was approximately KRW1.8 million higher per patient than continuing with standard HI treatment. Most of the increase was attributable to increased treatment and patient management costs, partly as a result of increased life expectancy on BIAsp 30. In the base-case analysis, the ICER was approximately KRW5.9 million, substantially below a recently used cost-effectiveness threshold value of KRW25 million [28]. An extended discussion of pharmaceutical cost-effectiveness initiatives in South Korea can be found elsewhere [29]. Sensitivity analysis revealed efficacy parameters and time horizon to be key drivers of direct costs, although the ICER remained within the range of cost-effectiveness in almost all scenarios.

This is one of the first studies to assess the cost-effectiveness of a type 2 diabetes intervention within the South Korean setting, and as such, involved the collation of valuable information, particularly diabetes complication cost data. This information may be useful for future cost-effectiveness analyses in the Korean setting.

Many of the calculations that are performed in the model are based on data from landmark epidemiological studies and clinical trials, such as the Framingham Heart Study and the UKPDS. Both studies were performed in predominantly white populations and, therefore, may not necessarily provide representative risks for Asian populations. For example, diabetes is known to be an independent risk factor for coronary heart disease (CHD), and a recent study investigated the accuracy of Framingham CHD prediction scores, reporting that the risks of CHD events were systematically overestimated in some ethnic groups [30]. Nevertheless, there is currently a paucity of relevant epidemiological data from Asian populations, in particular, data suitable for the South Korean setting. It was necessary to assume the applicability of the landmark trials and studies to the South Korean setting and to use published Korean data to define the baseline prevalence of complications that were not recorded in PRESENT.

A number of caveats associated with computer simulation modeling should also be noted. One of the principal limitations of long-term outcome models is that this technique uses short-term data to project outcomes over time frames of up to 30 years. This process is associated with inherent uncertainties; however, in the absence of long-term data, computer simulation modeling represents one of the best tools available to predict long-term economic and clinical outcomes. Moreover, it is not viable to conduct clinical studies over such a long time period.

The results presented here suggest that BIAsp 30 is an efficacious intervention in terms of reducing HbA1c levels and the incidence of hypoglycemic events in South Koreans with type 2 diabetes who are poorly controlled on HI. BIAsp 30 treatment was associated with higher pharmacy and patient management costs compared with HI, at an ICER of KRW5,916,758 per QALY gained. BIAsp 30 is likely to be a cost-effective intervention for patients poorly controlled on HI.

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